ECOLOGY OF THE DINGO IN NORTHEASTERN NEW SOUTH WALES:

V*. Human Predation on The Dingo

by

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and

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ABSTRACT

The scalp bonus certificates of 18 614 dingoes destroyed on the mid-north coast of NSW between 1958 and 1983 were examined. Annual scalp returns were highest in 1961 (1 546), fell to 256 by 1974 then rose to 475 by 1983. The decline was associated more with a reduction in the area from which dingoes were taken rather than a reduced offtake from the overall area. Half the dingoes were taken by trapping and 37% were shot, although shooting, which was more opportunistic than trapping, became relatively more common during the period. The sex ratio of the dingoes killed was strongly biased towards males but there was evidence that this reflected the sex ratio in the dingo population. We suggest that the bias arose from higher natural mortality of female pups associated with their smaller size.

The number of hunters declined during the study. On average, each operated for 2.3 years (range 1-22) and killed 6.4 dingoes (range 1-231). A small group of hunters made a significant contribution to the total scalp take over time and there was some evidence of harvesting amongst this group. Two-thirds of the scalps were taken by property owners or their relatives and only 22% by hunters with no obvious association with the land on which they hunted. Because of this and the lack of any relationship between the cash value of the bonus and scalp returns, the value of the bonus system as an incentive to control dingoes is questionable.

INTRODUCTION

The dingo, *Canis familiaris dingo* Meyer 1793, is unique among native mammals in that it is declared vermin throughout most of Australia. The result of this is that there are organizations established to control dingoes, that bounties are often paid for their destruction and that there is a legal obligation on landholders to destroy them.

Bounties have been paid on dingo scalps in NSW for at least 100 years. In 1946 the administrative structure of the control organization was changed, resulting in the formation of four dingo destruction boards (now called wild dog control boards) on the eastern seaboard. Dingo control in the west of the state, including the maintenance of the border barrier fence, is administered separately by the Wild Dog Control Board under the Western Lands Commissioner. All boards function on rates collected from landholders supplemented by government subsidies which are usually proportional to the rates collected.

Despite the formalized administration and high cost of dingo control, the functioning of the bonus system has received scant attention. The only study is that of Woodall (1983) who examined the relationship between dingo and pig bonuses in Queensland. In this paper we examine 26 years of bonus payments (1958-83) by one of the NSW north coast control boards and report on the geographic distribution of scalp returns, the relative success of destruction methods, the sex and age of dingoes destroyed and the relationships between hunters (who collect the bonus) and property owners.

METHODS

The study area covered the Lower North Coast and Tablelands Wild Dog Control Board area. This (see Fig. 2) is approximately 24 000 km^2 and lies between Coffs Harbour and Port Stephens on the north coast and extends approximately 160 km inland (30°30'to 32°30'S; 150°00' to 152°30'E). It includes the Pastures Protection Boards of Port Macquarie and Gloucester and parts of the Armidale, Tamworth and Upper Hunter Boards. The topography and landuse throughout the area is varied, as it includes the coastal hinterlands and ranges and the eastern edge of the tableland with its associated escarpments and gorges. Cattle grazing is widespread throughout the area but sheep are restricted to the tablelands.

Bonus payments were made by the Wild Dog Board on receipt of two certificates, one completed by the hunter and the second by the landholder. The data were taken from the hunters' certificates and checked against the landholders' certificates. Both were available from 1958 to the present. Prior to 1961 they showed the names and addresses of the hunter and property owner, the parish and Pastures Protection Board in which the dingo was destroyed, the date of destruction and whether the dingo was an adult or pup. Since 1961 the sex of the dingo has been added to both certificates and the method of destruction to the hunter's certificate, and more detailed analyses were possible after that year.

The data were collated by hunter, encoded and sorted using a data base management system, SYSTEM 1022 (Software House 1983), on the computer at the University of new England. This sorting was into three broad categories: information about the dingoes, the methods of destruction and the relationship between hunters and property owners.

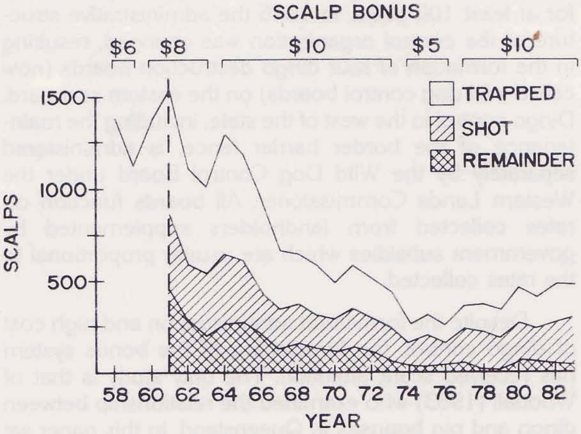

Fig. 1. Annual scalp returns between 1958 and 1983 with the contribution by each method after 1961.

RESULTS

Number of Scalps

Bonuses were paid for 18 614 scalps during the period studied and annual figures, along with the values of the bonus, are shown in Fig. 1. The highest number was received in 1961, after which scalp returns declined until 1974 and then rose slightly. During much of the period a basic bonus was paid to all hunters with an additional bonus to members of dingo destruction associations and this complicated the interpretation of the relationship between scalp returns and the value of the bonus. However, examination of the financial records of the Board revealed that the additional bonus was paid on between 80% and 100% of scalps in different years. Thus most hunters received the full bonus.

There was no obvious relationship between the number of scalps passed and the monetary value of the bonus, $10 between 1964 and 1983 except for a reduction to $5 between 1974 and 1976. As an approximation of real value, this was 20% of average weekly earnings in 1964 but less than 3% by 1983. However, the decline in scalp returns was not simply related to this decline in the real value of the bonus, as returns fell steeply between 1964 and 1970 during a period of moderate wage increase and rose between 1976 and 1983 in a period of sharp wage increases.

Density and distribution of scalps

The mean annual density and distribution of scalps for the periods 1958-63 and 1979-83 are shown in Fig. 2. The area from which scalps were passed declined from 16 500 km^2 per year in the former period to 7 800 km^2 per year in the latter and the distribution became patchy. The decline in scalp density from 7.6 to 5.6 scalps 100 km^{-2} yr^{-1} respectively was not as great. The intervening years were consistent with these trends.

Sex and age of dingoes

In both pups and adults the sex ratio was biased away from parity towards males. This was more marked in the adults (0.64 females:1 male) than in the pups (0.85:1) and this difference between age classes was significant (χ^2 21.23, 1 d.f., $P<0.001$).

From the scalp certificates it was apparent that often a number of pups were caught together. A group of pups was defined as all pups caught on the same day by one hunter in the one locality and the frequency of

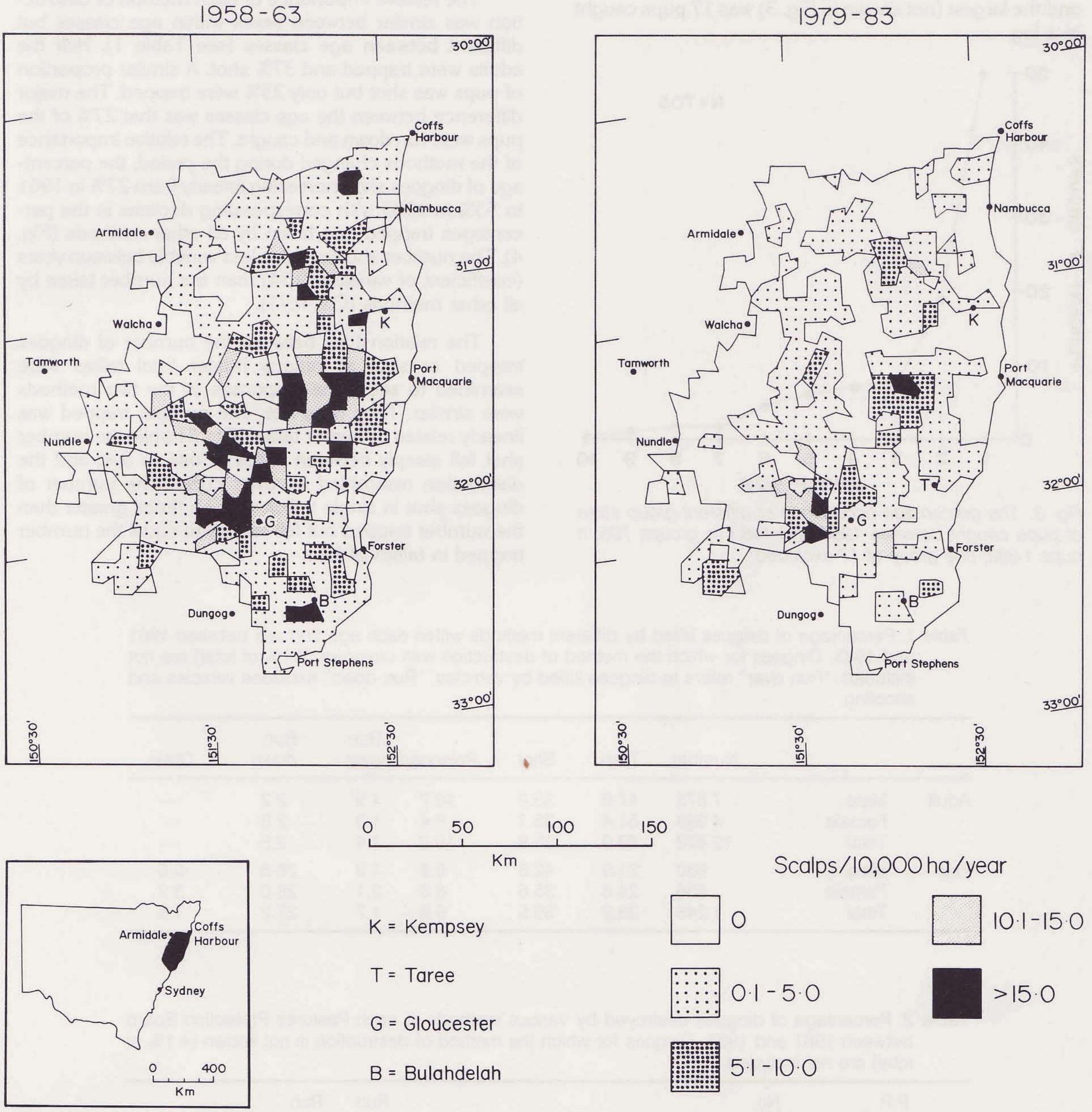

Fig. 2. Mean annual distribution and density of scalps for the periods 1958-63 and 1979-83. The location of the study area is shown in the smaller map.

occurrence of the various group sizes is shown in Fig. 3. The most common group size was 1, the mean was 2.4 and the largest (not shown in Fig. 3) was 17 pups caught in a log.

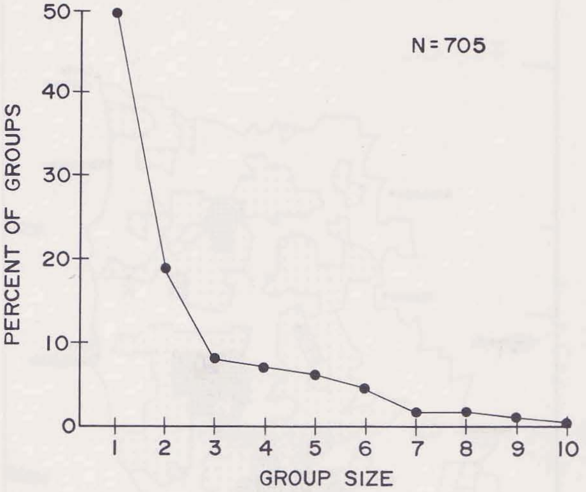

Fig. 3. The percentage occurrence of different group sizes of pups caught between 1958 and 1983 (n groups 705; n pups 1 682; one group of 17 excluded).

Method of destruction, age and sex

The relative importance of each method of destruction was similar between sexes within age classes but different between age classes (see Table 1). Half the adults were trapped and 37% shot. A similar proportion of pups was shot but only 23% were trapped. The major difference between the age classes was that 27% of the pups were run down and caught. The relative importance of the methods changed during the period, the percentage of dingoes shot increasing linearly from 27% in 1961 to 53% in 1983 with corresponding declines in the percentages trapped and taken by all other methods (Fig. 4). The number shot was also less variable between years (coefficient of variation 0.34) than the number taken by all other methods (C.V. 0.71).

The relationships between the number of dingoes trapped or shot at various hunter total tallies were examined to see if the responses to the two methods were similar. They were not. The number trapped was linearly related to hunter tallies (Fig. 5) while the number shot fell steeply between tallies of one to five, and the distribution resembled a power curve. The number of dingoes shot in single tallies was 2.5 times greater than the number trapped but fell steeply to equal the number trapped in tallies of four.

Table 1. Percentage of dingoes killed by different methods within each age and sex between 1961 and 1983. Dingoes for which the method of destruction was unknown (4.1% of total) are not included. "Run over" refers to dingoes killed by vehicles. "Run down" excludes vehicles and shooting.

		Number	Trap	Shot	Poisoned	Run over	Run down	Other
Adult	Male	7 873	47.6	38.0	10.7	1.5	2.2	—
	Female	4 999	51.4	35.1	9.4	1.3	2.8	—
	Total	12 872	49.0	36.9	10.2	1.4	2.5	—
Pup	Male	680	21.9	42.8	6.8	1.3	26.6	0.6
	Female	586	24.8	35.6	6.3	2.1	28.0	3.2
	Total	1 248	23.2	39.5	6.6	1.7	27.2	1.8

Table 2. Percentage of dingoes destroyed by various methods in each Pastures Protection Board between 1961 and 1983. Dingoes for which the method of destruction is not known (4.1% of total) are not included.

P.P. Board	No. Scalps	Trapped	Shot	Poisoned	Run Over	Run Down	Other
Tamworth and Upper Hunter	456	68.6	30.3	0.2	—	0.9	—
Armidale	1 499	62.9	24.9	6.1	1.1	4.1	0.9
Gloucester	6 345	51.8	32.6	7.6	1.2	6.6	0.2
Port Macquarie	5 820	35.4	45.7	14.1	1.9	2.9	—
Total	14 120	46.7	37.1	9.9	1.5	4.6	0.2

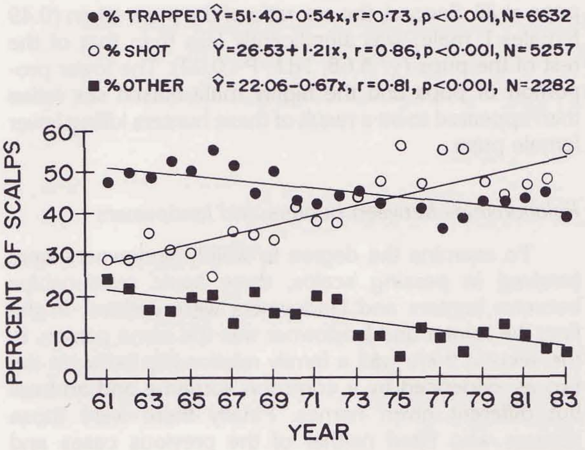

Fig. 4. Changes in the relative frequency of scalps taken by different methods between 1961 and 1983.

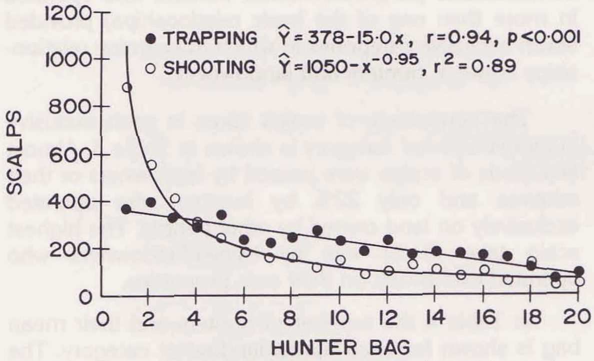

Fig. 5. The number of scalps taken by trapping and shooting at different hunter bag (tally) sizes.

The samples of adults trapped, shot and poisoned were large enough to compare the sex ratios (females:males). These were 0.69:1, 0.59:1 and 0.56:1 respectively and were significantly different between trapping and shooting (χ^2 15.50, 1d.f., P<0.001) and trapping and poisoning (χ^2 10.80, 1d.f., P<0.005) but not between shooting and poisoning.

Geographic differences in methods of destruction

The relative importance of each method in each Pasture Protection Board is shown in Table 2. Most scalps were taken by trapping in all except the Port Macquarie Board, where the majority of animals were shot. Poisoning was also twice as important in this Board as in any other.

The number of hunters

During the study period 2 902 hunters passed scalps. The number of hunters declined each year from 1958 to 1974 then remained relatively constant, with a maximum of 486 in 1961 and minimum of 101 in 1976. This decline resulted from the fact that while on average 35% of hunters were new each year, 50% permanently left the records. Thus only 75% of the hunters leaving were replaced. The density of hunters in the area from which scalps were taken also declined from approximately 3 per 100 km² in 1958 to 1.5 per 100 km² in 1983.

Years of hunting

The mean number of years a hunter passed scalps was 2.3 with a range from one to 22 years. Fifty-seven per cent of hunters operated in only one year and took 16% of the scalps, while 94% operated for five or less years and passed 54% of the scalps. The mean annual catch of hunters increased linearly as the number of years they operated increased, from two scalps for those operating in only one year to five scalps for those who operated in 20 or more years (see Fig. 6).

Bag size

The mean total bag was 6.4 scalps with a range from 1 to 231 and 75% of hunters caught five or less dingoes. The mean annual bag was 2.8 scalps per hunter and it fell from 3 in 1958 to 2 in 1974 then rose to approximately 3.5 in 1983. The largest bag in one year was 53 scalps.

A small group of hunters took considerably more scalps than the others and warranted separate examination. These 12 hunters passed 8.2% (1 534) of the scalps

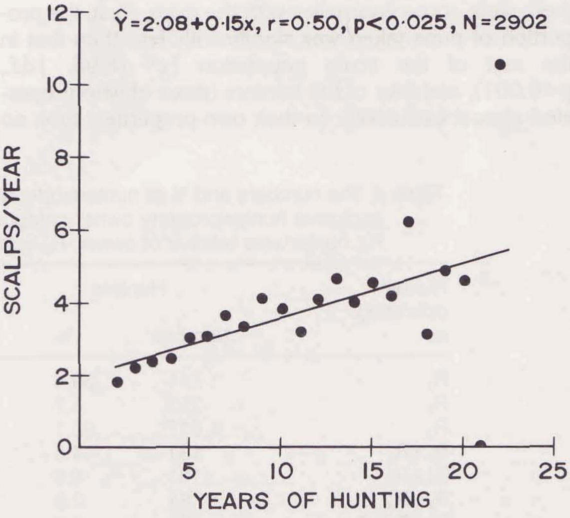

Fig. 6. The relationship between the number of years a hunter operated and the mean number of scalps per year (n hunters 2 902; n scalps 18 614).

Table 3. Percentage of scalps taken within each exclusive hunter/property owner category 1958-83 (n=18 572). R_1, hunter was property owner; R_2, hunter was a relative of the owner; R_3, hunter not R_1 or R_2.

Hunter operating as	% of scalps from property of: Hunter	Relative	Other	Total
R_1	31.3	—	—	31.3
R_2	—	3.8	—	3.8
R_3	—	—	22.0	22.0
R_1+R_2	5.8	3.4	—	9.2
R_1+R_3	8.8	—	6.7	15.6
R_2+R_3	—	1.7	3.5	5.2
$R_1+R_2+R_3$	4.5	3.0	5.3	12.8
Total	50.4	11.9	37.6	99.9

and averaged 7.7 scalps per year (range 4.6 to 14.2) for an average of 16 years (range 12 to 22); the corresponding figures for all hunters were 2.8 scalps per year in 2.3 years. The methods they used varied; six trapped more than 70% of their dingoes, two shot more than 70% and the remaining four were similar to the means for all hunters. Nine operated almost exclusively on their own properties while the other three were almost exclusive to other people's properties, and as such appear to be the only "professional" hunters of any consequence since 1958. All hunted in cattle country and none in sheep country and the four with the highest tallies operated in the same group of parishes around the Hastings River west of Wauchope.

The sex ratio of the adults they caught (0.66) was not significantly different from that of all adults. However, there were some anomalies with the pups. First, the proportion of pups taken was significantly less than that in the rest of the scalp population (χ^2 18.96, 1d.f., p<0.001), and four of the hunters (three of whom operated almost exclusively on their own properties) took no pups at all. Second, the sex ratio of the pups taken (0.49 females:1 male) was significantly less than that of the rest of the pups (χ^2 5.68, 1d.f., P<0.02). The lower proportion of pups and the highly male biased sex ratios then appeared to be a result of these hunters killing fewer female pups.

Relationships between hunters and landowners

To examine the degree to which landowners were involved in passing scalps, three basic relationships between hunters and landowners were defined. In the first, the hunter and landowner was the same person. In the second there was a family relationship between the two as evidenced by a common surname and address but different given names. Finally there were those hunters who fitted neither of the previous cases and these were assumed to have no connection with the landowner. The three relationships plus their four unique combinations (to accommodate hunters who operated in more than one of the basic relationships) provided seven exclusive categories in which to examine relationships between hunters and landowners.

The percentage of scalps taken in each exclusive hunter/landowner category is shown in Table 3. Almost two-thirds of scalps were passed by landowners or their relatives and only 22% by hunters who operated exclusively on land owned by other people. The highest scalp take (31%) was by hunter/landowners who operated exclusively on their own properties.

In Table 4 the number of hunters and their mean bag is shown for each hunter/landowner category. The largest group of hunters (39%) was the hunter/landowners with a mean bag of 5.1 followed by the hunter/non-landowners who had a mean bag of 4.0. The largest bags were attributable to hunters who operated across two or more hunter/landowner categories, and the highest mean bag to the small group of hunters who operated in all three categories.

Table 4. The numbers and % of hunters operating, and the average number of scalps/hunter in each exclusive hunter/property owner category from 1958 to 1983. R_1, hunter was property owner; R_2, hunter was relative of owner; R_3 hunter was not R_1 or R_2.

Hunter operating as	Hunters		Scalps/hunter from property of:			
	Number	%	Hunter	Relative	Other	Total
R_1	1 141	39.4	5.09	—	—	5.09
R_2	253	8.7	—	2.82	—	2.82
R_3	1 017	35.1	—	—	4.03	4.03
R_1+R_2	131	4.5	8.23	4.85	—	13.08
R_1+R_3	191	6.6	8.58	—	6.55	15.14
R_2+R_3	84	2.9	—	3.83	7.71	11.55
$R_1+R_2+R_3$	78	2.7	10.83	7.03	12.68	30.54
Total	2 895	99.9 $\bar{x}$	6.08	4.06	5.10	6.42

DISCUSSION

During the years 1958-83, trapping and shooting were the major methods of killing dingoes for the scalp bonus in the Lower North Coast and Tablelands Wild Dog Control Board and accounted for 85% of the scalps. The results from the application of the two methods were different. The number of dingoes trapped declined slowly and linearly as hunter bag size increased; in contrast the number of dingoes shot declined rapidly from 2.5 times more than those trapped in bags of one to less than the number trapped at bag size five. This, combined with the fact that half the shot dingoes were taken as part of bags of five or less, suggested shooting was a much more opportunistic method of control than trapping. This was consistent with the actual field practices. Trapping requires the acquisition, setting and maintenance of traps and in that sense is deliberate or premeditated. On the other hand, shooting simply necessitates the availability of a weapon if a dingo is seen. The exception to this is the hunter who "howls up" dingoes and shoots them.

The proportion of dingoes shot increased during the study period. This reflected the decline in the number of dingoes trapped while the number shot remained relatively more constant. Hence there appeared to have been a decline in interest in the premeditated destruction of dingoes while opportunistic killing remained relatively constant. The differences in the relative proportions of dingoes taken by each method in the different Pastures Protection Boards may have a similar explanation. The highest proportion of trapped animals came from sheep areas and the lowest from cattle areas, implying that more deliberate effort was directed at control in sheep areas.

The number of hunters declined until 1974 then remained relatively constant. While the area from which scalps were passed also declined, the density of hunters fell. This suggested a decline in interest in killing dingoes for scalps and this was consistent with the decline in the relative importance of trapping. In absolute terms the number of hunters operating was very low and in each of the last 10 years was approximately one hunter per 100 properties. Active participation in the destruction of dingoes through the scalp bonus system was then not widespread even among the grazing community.

More than half the hunters operated in only one year and averaged less than two scalps each. Annual bag size increased with the number of years a hunter operated, suggesting that success at killing dingoes increased with time. Yearly bag size increased between 1974 and 1983 while hunter density declined. Hunters who operated during that period were then more successful and it was a reasonable assumption that this involved more hunter effort. Thus while there was a decline in interest in killing dingoes for the bonus amongst the general population, there was apparently greater interest amongst those hunters who operated.

A small group of hunters who were both successful and persistent made a significant contribution to the total scalp take over the period. The majority of them specialized as either a trapper or shooter, indicating that the absolute success of each method was probably a function of hunter skill. These hunters recorded a significantly lower proportion of female pups than other hunters and it appears that at least some of them were harvesting dingoes (the harvesting may have been more associated with the maintenance of a reputation as a dingo hunter than with the bonus). Other evidence is that they took relatively fewer pups than average and, as three-quarters of them operated on their own properties, could reasonably have been expected to take all pups if dingoes were hunted because they were a problem. Furthermore, it is reasonable to assume that these hunters spent considerable time hunting and had a good knowledge of dingoes and so could have been expected to find more litters of pups than the average hunter.

The value of the scalp bonus as an incentive for dingo control was difficult to assess. There was no obvious relationship between the number of scalps passed and either the monetary or real value of the bonus. The bonus failed to attract a large number of hunters (approximately 1 per 100 properties each year between 1976 and 1983), and two-thirds of the scalps were passed by property owners or their relatives. While it could be argued that the bonus was an incentive to this group, it is an equally valid argument that no additional incentive should be necessary to a landholder if dingoes are a problem. Indeed, if the anecdotal evidence of stock losses is correct, the monetary value of the bonus is trivial by comparison.

Woodall (1983) assumed that annual bounty payments in Queensland reflected changes in the dingo population. It is unlikely that this assumption can be made in the present study as changes in attitudes towards dingo control, indicated by the shift in emphasis from premeditated to opportunistic control, were at least implicated in the decline in scalp returns. Extrapolating changes in bonus payments to the status of the dingo population must then be done with caution.

The area from which scalps were passed halved during the study period. Some of this reduction was associated with landclearing and development, particularly along the coast, leading to a reduction in the distribution of dingoes. However, the reduced distribution may not be as great as the data suggested, as dingoes are known to be present in a number of parishes from which no scalps were passed (for example, two parishes in the study area of Harden 1985). In the areas from which scalps were passed, their density declined by only

25% during the period studied. Hence the overall decline in scalp returns was largely due to the reduced area from which scalps were taken and affected to a lesser extent only by lower scalp returns from these areas. Because of changes in hunter attitudes, the halving of hunter density and a concurrent increase in the number of dingoes taken per hunter, it was difficult to assess what impact hunting had on dingo populations. Collectively those factors suggested that the reduction was not severe.

Declining scalp returns in the study area have been used as evidence of the effectiveness of dingo control by aerial baiting with 1080. Three factors caution against this interpretation. First, it cannot be assumed that scalp returns reflect the size of the dingo population. Second, aerial baiting was not commonly practised until 1970 and scalp returns declined more rapidly before rather than after that year. Finally, while records of the extent of aerial baiting were scant until recent years, at least half the study area was never baited and recent baiting has been restricted to the western edge of the area. Thus declining scalp returns in a large proportion of the study area could not be attributed to aerial baiting.

The reported sex ratio of the dingoes killed for the scalp bonus was particularly interesting. While there was some significant differences amongst the ratios for adults killed by the different methods, all methods were heavily biased towards males (range 0.56 to 0.69 females:1 male). It was unlikely that methods dependent upon factors as varied as lures of biological material (trapping), food (poisoning and trapping) and opportunism (shooting) were all male biased. This bias was also constant in time with little between year variation (coefficient of variation between years 0.09). We then suggest that the male biased sex ratio in dingoes destroyed for the scalp bonus reflected the sex ratio in the dingo population.

The sex ratio of the pups (0.85 females:1 male) was also male biased but closer to parity than the adults. Thus it appeared that the sex ratio became progressively more male biased by adulthood. This implies a higher mortality of juvenile females. Such a differential mortality could occur through a simple mechanism. From an early age dingoes are sexually dimorphic in size with males up to 50% heavier than females (Bekoff *et al.* 1981; Harden, unpublished data). Harden (1981) suggested that pup mortality after independence from the parents was related to size as "they are both too small and inexperienced to hunt adequately for themselves and many die of starvation". Hence the smaller size of the female pups places them at a disadvantage relative to the males and could result in a higher mortality, producing the male biased sex ratio observed in the scalp data.

The hypothesis we have advanced of a male biased dingo population has important biological implications and requires testing. From the present study its validity depends upon two assumptions. The first is that the scalp records were accurate. This seems reasonable when records collected by a large number of hunters over a wide area were consistent over a long period of time. The second is that the methods used to kill dingoes were not all male biased. This can only be tested by the collection of sufficient data from a wild population by methods independent of those used in this study. This would be particularly difficult, as the full spectrum of methods for collecting dingoes were used in this study, and the low density and cryptic nature of the animal in this region makes it unlikely that sufficient data could be collected by observational studies.

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